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TRANSPORTATION LABORATORY
RESEARCH REPORT

AN EVALUATION OF ENCASEMENT REQUIREMENTS FOR THERMOPLASTIC GAS PRESSURE PIPE

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16. ABSTRACT

Encasement requirements for thermoplastic gas pressure pipe are reviewed and evaluated for below grade installations within highway rights-of-way. The report presents and analyzes information obtained from gas company representatives and various references. As such, the report does not represent a complete nor exhaustive study.

Polyethylene conforming to ASTM Designation: D2513 Grade PE 2306 is the most commonly used thermoplastic for natural gas transmission lines in California. Indications are, considering the depth of the study made, that it is adequate for the external and internal pressures generally associated with buried low-pressure gas pipelines. The major objection or concern to the unrestricted use of thermoplastic pipe without encasement rests in the area of its vulnerability to damage from excavation operations.

It is recommended that any permits issued for unencased thermoplastic pipe installation be granted on a site-by-site basis. Such permits should be contingent upon strict adherence to established installation procedures, close inspection and post-installation monitoring.

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DEPARTMENT OF TRANSPORTATION
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TRANSPORTATION LABORATORY

December 1975

TL No 646819

Mr. C. E. Forbes
Chief Engineer

Dear Sir:

I have approved and now submit for your information this final research project report titled:

AN EVALUATION OF ENCASEMENT REQUIREMENTS FOR
THERMOPLASTIC GAS PRESSURE PIPE

Study made by . . . . Structural Materials Branch

Under the Supervision of . . . . . . Eric F. Nordlin

Principal Investigator . . . . J. R. Stoker

Co-Investigator . . . . J. P. Dusel, Jr.

Report Prepared by . . . . R. A. Swirsky

Very truly yours,

George A. Hill

GEORGE A. HILL
Chief, Office of Transportation Laboratory

Attachment

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This research was initiated by the Longitudinal Encroachment Committee composed of representatives of the Division of Right-of-Way, Project Development, and Maintenance and Operations of the California Department of Transportation. The contents of this report reflect the views of the Transportation Laboratory which is responsible for the facts and the accuracy of these data presented herein. The contents do not necessarily reflect the official views or policies of the State of California. This report does not constitute a standard, specification or regulation.

The authors wish to express their appreciation for the assistance provided by the following individuals and the organizations they represent:

Irving Hogan	California Public Utilities Commission
Bill Ross	Pacific Gas and Electric Company
Tom Temen	Pacific Gas and Electric Company
Tom Benson	Pacific Gas and Electric Company
Jerry Lucas	Southern California Gas Company
Jim Sharp	Southern California Gas Company

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I. INTRODUCTION

A. Background

Numerous requests have been made to the California Department of Transportation (Caltrans) over the past several years by certain major utility companies for permission to install polyethylene (PE) thermoplastic pipe for natural gas transmission lines within state highway rights-of-way without encasement. The current policy of Caltrans as stated in "Policy on Encroachments in Highway Rights-of-Way" dated May 1974 (refer to Appendix A) is fairly well defined with regards to encasement requirements for steel pipelines. This policy is, however, silent on encasement requirements for plastic pipe although it can be interpreted to imply the need for such protection.

The purpose of this study was to become familiar with the current state of the art, to present available information relative to the encasement requirements of thermoplastic natural gas pipelines, and to evaluate the facts related to the structural and safety aspects of plastic pipe and encasement requirements.

Some of the information contained in this report was discussed at a meeting held on February 26, 1975 at the Transportation Laboratory (see Appendix B for a summary of the meeting). Representatives from two major natural gas utility companies (Pacific Gas and Electric Company - PG&E - and Southern California Gas Company - SCG) and the California Public Utilities Commission, as well as Caltrans personnel from the Divisions of Right-of-Way, Project Development, Structures, Construction and Research, and Maintenance and Operations attended the meeting.

B. General Information

The following is a comparative evaluation (1)* of some of the polymers used for thermoplastic pipe fabrication.

*Numbers in parenthesis refer to the references at conclusion of report.

Polyethylene - Polyethylene pipe's biggest assets are its flexibility, light weight, and low cost. It also has high impact strength and good chemical resistance. It has a wide temperature range (-65° to 120°F), but is limited to relatively low-pressure applications.

Polyvinyl Chloride (PVC) - A rigid pipe, it has good dimensional and weathering properties and high tensile strength. Type I PVC has excellent chemical resistance but low impact strength. Type II PVC has high impact resistance but sacrifices chemical resistance.

Acrylonitrile-butadiene-styrene (ABS) - Relatively rigid, ABS has excellent impact strength and high heat resistance (to 180°F). It has good chemical resistance, but not as good as that of PVC.

Polypropylene - Polypropylene pipe is the lightest of the plastic pipes. It is stronger, more rigid, and has higher temperature limits than polyethylene. However, it has poor low-temperature properties.

Cellulose acetate butyrate - Cellulose acetate butyrate is the only transparent plastic pipe. It is flexible, light, and has good corrosion and weathering resistance. It suffers from low working pressures and brittleness at low temepratures.

The type of thermoplastic pipe most widely used by major California gas utility companies is a medium density polyethylene designated as PE 2306 which conforms to ASTM Designation: D2513 - Standard Specification for Thermoplastic Gas Presure Pipe, Tubing, and Fittings(2). Of the thermoplastics in use polyethylene is rated(3) as the best performer in the areas of toughness, temperature and chemical resistance, flexibility and joining methods.

Thermoplastic pipes are used in low-pressure (60 psi maximum) gas lines with a maximum nominal diameter of 4 inches.

The most commonly used diameter-to-wall thickness ratios range from 7 for the smallest diameters to 11 for the 4 inch diameter lines. This ratio is known as the SDR or standard dimension ratio. Plastic pipe is supplied in 1500 foot coiled lengths for diameters to 3 inches. The larger sizes are supplied in 38 foot straight lengths.

Minimum soil cover generally required by Caltrans has been 30 inches. The PUC requires a minimum of 36 inches of cover in normal soil in all instances except in rural locations, where a minimum of 30 inches is allowed.

II. SUMMARY OF FINDINGS AND CONCLUSIONS

The following findings and conclusions are based solely upon an evaluation of information obtained from gas utility company representatives and various references cited in the report text.

This report is a summary of the significant findings extracted from these sources. A complete and exhaustive study of the encasement of plastic pipe used for natural gas distribution lines was not within the scope of this research.

From this brief study, it is obvious that there is a real need to establish consistent, well defined policies regarding the encasement of plastic pipe within freeway and highway rights-of-way.

A. General

(1) The most common thermoplastic pipe used in California for natural gas transmission is a medium density polyethylene conforming to ASTM Designation: PE2306 explained in ASTM Designation: D2513.

(2) "Dig-ins" account for approximately half of all steel and plastic pipe failures.

(3) The potential for accidental ignition of escaping natural gas is the same for plastic or steel pipelines according to utility company information.

(4) A policy which unconditionally allows thermoplastic gas pipe installations without encasement would appear to represent a departure from current AASHTO guidelines.

(5) It does not appear that a change in current policy would result in direct monetary savings to the State or the public; however, allowing unencased plastic pipe would save the utility companies substantial installation and maintenance costs.

B. Unencased Natural Gas Pipelines

(1) Unencased polyethylene thermoplastic pipe up to 4 inches in diameter with a standard dimension ratio of 11 or less installed at currently required depths of cover appears to be structurally adequate for the internal and external pressures normally encountered in the distribution of natural gas at pressures not exceeding 60 psi.

(2) Joints produced in thermoplastic pipe by butt-fusion or socket-fusion in strict conformance to the requirements of ASTM D2657 are leak-proof and reliable.

(3) Sufficient care and training necessary to form sound joints in thermoplastic pipe appears to be exercised by the gas utility companies.

(4) Thermoplastic pipelines require fewer joints than steel lines.

(5) Thermoplastic pipe is more easily punctured or severed than steel pipe.

(6) Polyethylene thermoplastic pipe is more easily and quickly repaired than steel pipe.

(7) Gas leakage can be controlled or stopped more rapidly in polyethylene thermoplastic pipelines than in steel lines.

(8) Polyethylene thermoplastic pipe has desireable ductile and impact resistance properties which appear, based on evaluations to date, to be independant of age.

(9) Thermoplastic pipe does not transmit impact loads over as great a distance as steel pipe.

(10) Polyethylene thermoplastic pipe can probably sustain greater movement resulting from differential settlement without failure than steel pipe.

(11) Polyethylene thermoplastic pipe does not appear to be susceptible to oxidation or chemical degradation from constituents normally found in soil or processed natural gas.

(12) Corrosion leaks in steel pipe are a major problem.

C. <u>Encased Natural Gas Pipelines</u>

(1) The use of encasement minimizes the occurrences of damage from dig-ins.

(2) The use of encasement can facilitate pipeline replacement but it can also limit access to the line.

(3) The rigidity of an encasing pipe can lead to failure of the carrier pipe when excessive differential settlement occurs.

(4) Encasement provides a pathway and reservoir for escaping gas thereby increasing the potential for a serious explosion and the area over which damage could occur.

(5) Cathodically protected encasement requires periodic inspection and maintenance.

III. RECOMMENDATIONS

(1) It is recommended that PE 2306 polyethylene or equivalent thermoplastic gas pressure pipe conforming to ASTM Designation: D2513 continue to receive acceptance subject to PUC requirements for use in low-pressure (60 psi maximum) natural gas pipelines.

(2) Minimum depths of cover currently required should be maintained with consideration given to establishing greater cover requirements at locations where a high potential exists for exposure to dig-in.

(3) Considering the present state of the art, and the potential hazards and legal liabilities associated with a gas line failure, it is recommended that permission to install thermoplastic gas pipelines without encasement be granted on a site-by-site basis so that actual conditions for installation can be thoroughly evaluated. This evaluation should at least include a study of geologic formations, soil type and condition, foundation stability, surface and subsurface water drainage patterns, seismic activity, traffic volume and dig-in exposure potential.

(4) Granting of permission to install unencased plastic pipe should also be contingent upon the close adherence to company installation procedures with provisions for rigorous inspection and pipeline delineation requirements.

(5) Follow-up inspection and record keeping appear to be warranted considering the potential dangers associated with natural gas transmission and the absence of long-term data about unencased plastic pipe installations.

(6) The legal aspects of a decision to permit unencased thermoplastic pipe installed transversely or parallel to our state highways should be thoroughly investigated.

(7) It is recommended that the Office of Pipeline Safety of the United States Department of Transportation be contacted to determine the status of the industry-wide survey on the value of pipeline casing suggested by the National Transportation Safety Board.

IV. DISCUSSION

A. Structural Considerations

1. Internal Pressure Requirements

Allowable internal operating pressure for polyethylene pipe is determined in accordance with the following design formula as set forth in PUC General Order No. 112-C(4):

$$P = 2S \frac{t}{(D-t)} \times F$$

Where P = design pressure, psi
S = long-term hydrostatic strength stress in circumferential or hoop direction, psi
t = specified wall thickness, inches
D = specified outside diameter, inches
F = design factor

This formula limits operating pressures to 60 psi for the plastic pipe sizes and wall thicknesses currently used by the gas companies. The design factor (reciprocal of the factor of oafety) ranges from 0.32 for rural areas to 0.20 for densely populated urban areas.

The long-term (100,000 hour) hydrostatic strength for PE 2306 pipe, tubing and fittings as stated in ASTM Designation: D2513 is 1250 psi. This standard also specifies a short-term burst strength pressure requirement of 500 psi and a long-term (1000 hour) sustained pressure test requirement of 265 psi. A considerable safety factor for internal pressure has therefore been incorporated in the design of plastic gas lines.

2. External Pressure Requirements

Various performance limits have been established(5) for buried flexible pipe. Generally stated, a performance limit "...is a deformation beyond which the pipe-soil system cannot perform adequately the services for which it was designed". Pipe deflection due to soil overburden and traffic loads is referred to as ring deflection and expressed as a percent decrease in vertical diameter. Allman(5) states that ring deflections for ODR 11 and 21 gas pipes buried three feet below street level in loose soil (70% standard density) and subject to H20 truck loading do not exceed maximum allowable values. Maximum allowable deflections are based on allowable strain (approximately 1.5%) in the pipe wall. This deflection equals 2.5% for SDR 11 pipe. Use of the design method suggested by Allman for buried polyethylene pipe insures that a pipe selected in accordance with this method is adequate for the anticipated external loads. This method does not consider the beneficial effects of soil arching which would probably be present for the pipe diameters under consideration. Both granular soils and soils with cohesion have this ability(6) to transfer loads directly over a buried structure to the surrounding soil. The percentage of load transfered via soil arching would depend upon actual site conditions, including type of soil, moisture content, soil density, soil cover, and nature and magnitude of impact loads.

When either steel or plastic pipe is used, external loadings due to dead and live loads, including impact, differential settlement, vibrations, or impact, can be sustained, provided that the loading is not extreme and the pipe has been properly designed and installed in firm stable soil surroundings. Polyethylene pipe exhibits moderately good impact resistance and extremely good ductility due to the manner in which the molecules of plastic are linked together. The Dupont Company has conducted research on and is currently studying the phenomena of strain-cracking and long-term buckling of buried polyethylene pipe. No evidence of any problems in this regard have surfaced to date. Steel pipe is more rigid and tougher than polyethylene pipe and cannot bend or deform as easily. Because of these differences in flexibility, polyethylene pipe can sustain greater deflections without failing than steel pipe. Whether steel or plastic is used, severe external loading and extreme differential settlement is a matter of concern.

3. Joint Strength and Reliability

The heat-fusion process of joining sections of plastic pipe or pipe to fittings has been shown(7,8) to produce pressure tight and reliable joints provided proper standards of manufacture are observed and that care is exercised in making the joints in the field. Butt-fusion and sleeve-fusion are the two main pipe joining techniques currently in use. Of these two, butt-fusion produces the stronger joint(7). However, butt-fusion is a more complicated process requiring more skill from the pipe layer(9).

Because pipe sizes to 3 inches in diameter are supplied in 1500 foot lengths, most transverse installations would not require joints beneath the roadway. Recommended practices for heat joining of thermoplastic pipe and fittings are set forth in ASTM Designation: D2657(2). During the heat-fusion process the bead which forms around the periphery of the joint is a good visual check on the quality of the joint. Once installed, the system is subjected to a stand-up pressure test as required by PUC General Order No. 112-C. The required pressure for this test is 150 percent of the maximum operating pressure or 50 psi, whichever is greater. For 60 psi pipelines, this amounts to a minimum test pressure of 90 psi. The requirements of this test (primarily a test of joint quality) do not appear to be consistent with the severity of the burst-strength and long-term hydrostatic strength tests previously mentioned for the pipe. At least one utility company, when qualifying their pipe installers, requires that the test unit fabricated by the installer be subjected to a minimum pressure of 500 psi. The test unit incorporates butt, socket, and saddle fusion joints and a mechanical joint using 1/2 to 3 inch diameter pipe.

4. Chemical Resistance

Tests (10) have shown that certain natural gas condensates such as aromatic and aliphatic hydrocarbons affect the pressure performance characteristics of various polyolefin (polyethylene, polybutylene and polypropylene) piping materials. The 10 to 12 percent reduction in tensile yield strength due to severe exposure conditions (samples soaked in condensate) is however almost fully recovered after a drying period.

This extreme condensate test condition would rarely if ever be encountered in a gas distribution system. Dryers which remove the bulk of liquid condensate are normally used at gas pumping stations. In an actual system, gas flow would tend to remove the remaining liquid condensate from the pipe walls, returning the condensate to the vapor phase.

The decrease in pipe strength due to possible exposure to liquid condensates is not considered to be significant (10) because of the large safety factors used in design.

Chemicals normally found in soil do not appear to have a deleterious effect upon any of the thermoplastics currently used for gas transmission lines. Oxidation, a serious corrosion problem with steel pipe, does not occur with thermoplastic pipe.

B. Safety Considerations

An written responses (Appendix C) to a Caltrans questionnaire, P.G. & E. and S.C.G. have both indicated confidence in unencased thermoplastic pipe installations from the standpoint of safety and overall performance.

The following considerations are the main concerns addressed in the questionnaire:

1. Gas Explosion Hazards

With any natural gas pipeline failure, a high potential for ignition and/or explosion exists. Approximately half of all pipeline failures are due to damage by mechanical equipment(9). Oteel pipelines generally produce sparks when struck with equipment, while the blowing gas in a plastic pipeline generates a static electrical charge. Leakage can occur from any number of other causes: poor workmanship and quality control, differential or excessive settlement of surrounding soil, and corrosion leaks in steel pipe being among the most common.

The safety of the traveling public as well as that of construction, maintenance or landscaping work crews would be jeopardized in the event of such failures in the proximity of a roadway. Structural damage to the roadway and/or appurtenant structures is also a ;ossibility in the event of an explosion. Traffic congestion resulting from repair work, either by the responsible gas company or state maintenance personnel, creates another hazardous situation for the traveling public.

Because the consequences of natural gas leakage from pipelines are potentially disastrous, safety is of the utmost concern with regard to encasement requirements for thermoplastic gas pipelines crossing under or paralleling state highways. The gas companies feel (Appendix C) that the potential for accidental ignition is not influenced by the type of piping material or the use or non-use of encasement.

2. Safety and Encasement

Present thinking reflects the feeling that encasement or the use of heavier walled steel pipe without a casing would prevent or at least reduce the instances of damage to the carrier pipe from excavations or other operations adjacent to the pipe. It would certainly be difficult to refute this argument.

There are, however, other considerations. In the event of a leak, if encasement is used, a pathway and reservoir for escaping gas from the inside carrier pipe is provided by the annular space between the carrier and casing pipes. Accidental ignition would most likely cause more severe and widespread damage under these circumstances than when ignition of leaking gas occurs around an unencased pipe.

Encasement, in at least one instance, has been thought to be a contributing factor in carrier pipe failure. The National Transportation safety board in its "Pipeline Accident Report: Michigan-Wisconsin Pipe Line Company/Monroe, Louisiana/March 2, 1974"(11) describes the failure of a high-pressure, 30-inch diameter steel gas pipeline encased by a 34-inch pipe. Repeated swelling and heaving of the surrounding soil caused the unrestrained carrier pipe to flex excessively. This flexing eventually led to the failure of a substandard girth weld. Without the encasement, the backfill would have limited the amount of carrier pipe deflection thereby reducing the tensile stresses in the pipe. The girth weld, although substandard, might not have failed at these lesser stress levels.

Thermoplastic pipe is, of course, more easily severed or punctured than steel pipe and therefore has a greater probability of failure in the immediate area of contact when struck. The relatively higher flexibility offered by polyethylene pipe, however, has a mitigating influence upon the extent of damage. Because of the rigidity of steel pipe, any impact is forcefully transmitted a distance on either side of the point of contact. This transmitted ampact load could fail or weaken adjacent pipe-to-pipe or pipe-to-fitting connections causing gas leaks which may not be readily apparent or detected.

When a line is severed or punctured, the resulting leak is more easily controlled and repaired in a plastic line; the plastic pipe can be simply pinched off with a special clamp to prevent the escape of gas until repairs are made.

Depending on the location, design and nature of a given installation, encasement can either facilitate carrier pipe replacement for repairs and system expansion or it can make access difficult and time consuming.

3. Utility Company Installation Procedures

The gas utility companies have established procedures and instructions for pipeline installation, joining and repair. Caltrans has received a copy of one utility's instructions for polyethylene piping(12). These procedures are comprehensive yet concise - important qualities if actual installations are to resemble those idealized in design and regulatory specifications. In the interests of safety and long-term satisfactory performance it would behoove organizations responsible for granting permits to establish provisions, procedures and controls for rigorous inspection of unencased thermoplastic pipe installations. Confidence that the various precautions set forth in the company instructions are followed, e.g., the prevention of accidental ignition from static electricity, could also be maintained by means of these controls.

4. Pipeline Location

There is a need to develop an above-the-ground marking system to facilitate the location of buried gas pipelines and more importantly, to warn workmen of the presence of a pipeline. At present, the utility companies do not use any visible delineation system. Plastic pipeline location is accomplished by means of a metallic wire buried with the pipe when it is initially installed. An electronic anstrument called a pipe locator, consisting of a high frequency signal transmitter and receiver, is used to detect the wire from ground level. The instrument can be used conductively or inductively. The conductive method is used when physical access to the locating wire is possible. It is the more accurate of the two methods.

The gas companies in coordination with other utilities are presently considering the use of above ground marking systems and the establishment of a "one-call" center. The markers would bear the telephone number of the center along with a message directing an individual to call before commencing with any excavation operations or in the event of an emergency. A representative from the involved utility could then be dispatched to the jobsite or the necessary information could be conveyed by telephone.

These procedures would help to prevent dig-ins and would speed emergency repairs.

5. Codes, Policies and Guidelines

Two heavily populated states, New York and Texas, do not permit the installation of plastic pipe under their roadways without encasement according to telephoned information.

None of the pertinent national codes and policies specifically require encasement of thermoplastic pipe except when installed in vaults or other subgrade enclosures. The following excerpts however, may be interpreted to imply the need for encasement.

a. PUC G.O. #112-C(4)

Section 192.317(a): Each transmission line or main must be protected from washouts, floods, unstable soil, landslides, or other hazards that may cause the pipe to move or to sustain abnormal loads.

Section 192.321(c): Plastic pipe must be installed so as to minimize shear or tensile stresses.

b. AASHTO "Policy on the Accommodation of Utilities on Freeway Rights-of-Way"(13)

Section (5c): Utilities crossing underground below the freeways shall be of durable materials and so installed as to virtually preclude any necessity for disturbing the roadways to perform maintenance or expansion operations.

c. American National Standard Code for Pressure Piping, Gas Transmission and Distribution Piping Systems, ANSI B31.8. - 1968(14)

Section 842.43(c) Plastic piping shall be installed in such a way that shear or tensile stresses resulting from construction, backfill, thermal contraction or external loading are minimized.

d. AASHTO "Guide for Accommodating Utilities on Highway Rights-of-Way"(15)

Allied Mechanical Protection: For some conditions pipeline crossings of the highway may be installed without encasement. Normally, such installations should be limited to open trenched construction.

Installation: Untrenched construction should be required for all pipeline crossings of controlled access and other major highways.

The following general statement taken from the last reference summarizes the main considerations for encasement:

"Definite guides for the encasement of pipelines cannot be fully resolved from present experience and knowledge. On one hand, an arbitrary policy of requiring encasement for all highway crossings is too expensive, not only to the utility consumer but also to the highway user. On the other hand, considering past experience and current appraisal of future hazard, it is not prudent to waive all encasement requirements. An intermediate policy should concede the highway agency's responsibility for safety of traffic and structural integrity of the roadway, placing the burden of proof on the utility if it contends for any particular location that encasement is unnecessary. Although such a policy should not require proof from the highway agency that encasement is necessary, the agency should not specify it without reason."

C. Research

Pipeline research is currently being conducted by the American Society of Civil Engineers in the areas of new construction techniques, methods of installation, materials, and policies for utility crossings of railroads and highways. One of the objectives of the research in the area of policies is to establish uniform standards for encased and unencased crossings.

The National Transportation Safety Board, in a previously mentioned pipeline accident report(11) recommended that the Office of Pipeline Safety of the Department of Transportation conduct an industrywide survey on the value of encasing pipelines beneath roads and railroads. It was further recommended that the study be undertaken in cooperation with AASHTO, FHWA and appropriate industry associations and engineering societies.

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VI. APPENDIX

A. Excerpts from California "Policy on Encroachments in Highway Rights-of-way"

May, 1974

Duct

A fabricated tube for receiving and containing conductors and cables.

Conduit

A duct or combination of ducts.

Communication Line

A circuit for telephone, telegraph, messenger-call, clock, police, fire alarm, community television antenna, or traffic control purposes.

Encasement

A sleeve or jacket.

Sleeve

A pipe in which a pipeline or conduit is inserted.

Jacket

An encasement of reinforced concrete poured around a pipeline or conduit.

Pressure Pipelines

Any pipeline flowing full shall be considered a pipeline under pressure.

SECTION 3. PIPELINES

3-1. General Encasement Requirements

3-1.1 Kind of Encasement

A sleeve shall be prescribed in preference to a poured reinforced concrete jacket wherever practicable. Consideration shall be given to type of soil, height of embankment, and economic conditions in considering the type of encasement to be prescribed. Any pipe used as a sleeve under the highway must meet culvert requirements with regard to strength and service life.

3-1.2 Size of Encasement

A sleeve approximately four inches larger than the outside diameter of the pipeline being encased should be used. Special consideration may be given to a larger clearance when required or under unusual conditions such as where settlement may be expected.

3-1.3 Length of Encasement

On freeways and expressways transverse encroachment requiring encasement shall be encased between the access control lines. Exception may be made upon showing that full encasement is impractical and with prior Division of Highways' Maintenance Branch approval.

On conventional highways transverse encasement shall extend at least five feet beyond the existing slope limits and planned future slope limits. Where the slope limit is not clearly definable as in the case of nearly ground level grade lines, encasement shall extend at least five feet beyond curb or shoulder lines.

Where longitudinal encroachments are permitted, encasement will be required when such facility is located on a bridge, under the roadbed or when encasement is desirable for reasons of public safety or protection of the highway. Consideration may be given to allowing facilities to remain under the roadbed in urban areas without encasement.

Service connections made to existing longitudinal facilities under the roadbed need not be encased unless the longitudinal facility is encased.

3-1.4 Protective Measures

The following measures are intended to maintain the integrity of the highway and avoid hazards by protecting the pipeline against structural damage or leakage:

1. Encasement in a Sleeve

   A sleeve serves these purposes:

   a. It prevents damage to the highway from a leaking carrier pipe and averts a traffic hazard from flammable fluids;

   b. It facilitates maintenance and replacement without interfering with or endangering traffic;

c. It safeguards the carrier pipe against excessive crushing or bending stresses; and

d. It reduces the likelihood of damage from unanticipated corrosion due to stray currents or aggressive salts.

2. Reinforced Concrete Jacket

A jacket around a pipe increases resistance to crushing, bending, and the accompanying joint stresses.

3. Reinforced Concrete Cradle

A cradle under a pipe imparts greater resistance to bending and crushing.

4. Reinforced Concrete Slab

A slab placed above or over existing undisturbed pipes or other conduits distributes and equalizes a superimposed load.

3-1.5 Special Conditions

Under special conditions consideration shall be given to encasing pipes that otherwise would not require encasement. For example, appreciable settlement of the supporting ground can cause a break in asbestos cement pipes and disjointing of other kinds of rigid pipe consisting of short lengths.

For pipes 24 inches in diameter and larger, the requirement for a sleeve or encasement may be waived in favor of additional pipe wall thickness.

In special cases consideration will be given to waiving encasement requirements; for example, if cathodic protection is required and there is reasonable assurance that it will be properly monitored.

Encasement may be required for installations of coated carrier pipes where there is no positive assurance against damage to protective pipe coatings. The steel or the cement mortar in mortar-coated steel pipes can deteriorate in adverse environments. Under these conditions, a paint coating over the mortar, cathodic protection, or both, may be required in lieu of encasement. Placement in a sleeve may be required to prevent the possibility of corrosion of field-coated joints and cracking of mortar coating during jacking or boring operations.

3-2. Pipelines Conveying Gas, Oil or Other Flammable Fluids

Pipelines conveying gas or oil are generally regarded in the same category as both carry flammable substances, and a break in the pipeline creates a hazard.

Pipelines of this type that are not dedicated to public use (public utility facilities) are not permitted to occupy the right of way longitudinally. Pipelines are not dedicated to public use unless they carry the product of more than one owner and are under the jurisdiction of the California Public Utilities Commission. Pipelines carrying hazardous materials can be required to have corrosion control measures as outlined in the appropriate Federal or California State PUC regulations. Evidence of compliance with these regulations must be submitted prior to approval of an encroachment permit.

3-2.1 Encasement

All pipelines in this category require encasement except under the following conditions:

1. Steel pipelines that have protective coating. See Article 3-1.5 (Special Conditions). Protective coatings may not be a substitute for cathodic protection. See Article 3-2.2 (Cathodic Protection).

2. Steel pipelines where cathodic protection is provided. Protective coating or cathodic protection will not exclude pipelines in this category from encasement requirements on bridges. See Article 5-2.2 (Encasement).

3. Steel gas pipelines installed by trenching methods and in accordance with PUC General Order No. 112-C provided that said pipelines have:

    a. Adequate protective coating and cathodic protection.

    b. Wall thickness of next heavier gauge than normally required by the carrier pipe.

    c. Sufficient diameter to allow insertion of a new carrier pipe in case of leakage or other failure.

3-2.2 Cathodic Protection

Cathodic protection of welded steel pipelines of sufficient strength may be permitted in lieu of encasement when site corrosion survey data is filed with the application and such data shows the pH of the soil and the minimum soil resistivity at proposed pipe depth. When the corrosion survey data dictates the use of cathodic protection, such protection shall be designed and maintained in a condition compatible with the specific environment.

3-3. Irrigation Pipelines

3-3.1 General Case

Ordinarily, irrigation pipelines operating under gravity need not be encased. When the flow is continuous for long periods of time or under pressure as in a sag pipe, watertight joints or encasement shall be required.

3-3.2 Existing Transverse Crossings by Irrigation Facilities

A right of way acquisition for widening or new alignment of a highway may require the provision of a modification or extension to, or substitute for, an existing irrigation facility crossing the existing highway or, in the case of new alignment, a new crossing. Liability for such work may be borne by the State in whole or in part, depending on the facts of the particular case and the applicable law.

1. High Pressure Pipelines

   A sleeve may be required for irrigation lines under pressure. On freeways and expressways the sleeve shall be normally extended over the full width between access control lines, but may be less than full width in special cases (see Section 3-1.3). On conventional highways it shall extend at least five feet outside the slope lines. The sleeve and pipe will remain the property of the State and the State will have the obligation to maintain and replace them.

2. Low Pressure Pipelines

   To convey irrigation water across the right of way, a pipe having a diameter of six inches larger than the diameter required to carry the flow may be provided, all of which may be installed and maintained at State expense. Should this pipeline deteriorate in the future, it will serve as a sleeve for a new pipe.

On freeways and expressways it shall extend over the full width between access control lines.

On conventional highways the pipe shall extend from right of way line to right of way line. Where impractical due to extremely wide right of way, consideration may be given to installing a lesser length of pipe. In such cases, ditch maintenance between the end of the pipe and right of way line will be the responsibility of the property owner.

3. Open Irrigation Ditch Converted to a Pipeline

To avoid carrying an open ditch across the right of way of freeways and expressways, the State shall install and maintain a pipeline across the right of way. The length and diameter of the pipe shall be as stated in subparagraph (2) above.

3-3.3 New Transverse Crossings By Irrigation Facilities

Where new transverse crossings of irrigation facilities are permitted, the provisions of Article 3-4.1 (General Case) and 3-3.2 (Existing Transverse Crossings By Irrigation Facilities) shall govern except that no part of the cost of installation and maintenance will be at the State's expense. On freeways and expressways maintenance shall be from outside the right of way.

No cutting of the pavement will be permitted. Such facilities shall be installed as outlined in Section 7 (Construction Methods).

3-4. Sewers

3-4.1 General Case

Sewer pipelines crossing any State highway, or lying longitudinally and underneath the roadbed, shall be encased or protected in some manner. The District Project Development Branch shall be responsible for determining the type of encasement or alternative protection required.

The provisions of Articles 3-1.3 (Length of Encasement), 1-7 (Transverse Encroachments), and 1-8 (Longitudinal Encroachments) will govern for both transverse and longitudinal installations.

3-4.2 Special Conditions

Special consideration shall be given to encasement of sewers if they are to be under embankments 10-feet high or more to avoid possible leaks or disjointing of the line. Such situations shall be reviewed by the District Project Development Branch and the need for encasement, if any, shall be determined by that Branch.

Encasement in a sleeve shall be required where detrimental subsidence of the ground under a fill is anticipated. In such an event, special consideration shall be given to a sleeve at least six inches larger than the largest outside diameter of the sewer pipeline. This is particularly important in the case of freeways, as access to the sewer is permitted only from outside the access control lines and the larger sleeve diameter facilitates inspection, repair and replacement of the pipeline.

Sewers within five feet of the natural ground surface or profile grade, consisting of clay pipe or other material susceptible to damage from construction equipment or highway traffic may be protected by a reinforced concrete slab over the pipe in lieu of encasement.

Clay pipes 12 inches or less in diameter need not be encased if they are more than five feet below undisturbed natural ground and subsidence is not a problem. New sewers on questionable subgrade shall be placed on a concrete cradle.

3-4.3 Other Requirements

Uncoated concrete and asbestos cement pipes located under the highway shall be designed to flow full as a safeguard against attack from generated acids. Otherwise, clay or coated pipes should be used.

3-5. Miscellaneous Requirements

3-5.1 Specifications

When applicable, the specifications given below shall serve as minimum requirements for pipelines. In case of conflict between specifications, the most conservative shall apply.

1. Metal Pipes

   a. The following specifications cover ferrous and nonferrous gas transmission and distribution piping systems. For pressure piping, California Public Utilities Commission General Orders shall apply. (Currently G.O. No. 112-C, which refers to American National Standards Institute Code for Gas Piping Systems, ANSI B-31.8-1967).

   b. For ferrous and nonferrous piping conveying fluids under préssure, other than gas, American National Standard Code for Pressure Piping, ANSI B-31.1-1965, shall apply.

   c. Cast iron pipes shall conform to the Standard Specifications issued by the Department of Transportation.

   d. Metal pipes used for underground encasement shall conform to the Standard Specifications.

2. Concrete and Asbestos Cement Pipes

   Such pipes shall not exceed the manufacturer's recommended pressure and shall conform to the Standard Specifications issued by the Department. When they are used for underground encasement, culvert requirements also shall apply.

3. Plastic Pipes

   Due to the variety of materials available, it is not considered practical to establish specific guidelines for use of plastics. Specifications should insure that the type of pipe is adequate for the intended purpose (refer to California Public Utilities Commission G.O. 112-C). A means for detection of nonmetallic material should be provided.

4. Pipe Joints

   Plain, reinforced concrete pipes, clay pipes and asbestos cement pipes conveying liquids under pressure shall be watertight under pressure and foreseeable conditions of expansion, contraction and settlement. Mortar, grout or other portland cement materials will not be allowed as joint sealants. Recommended joint seals include rubber, neoprene and similar synthetic products.

B. Summary of Meeting with Gas Industry, PUC and Caltrans Representatives

State of California

Business and Transportation Agency

Memorandum

To : Memo to File

Date: February 26, 1975

File : Policy, Pipeline Crossings

From : Structural Materials Branch
DEPARTMENT OF TRANSPORTATION
Transportation Laboratory

Subject:

At 9:00 a.m., February 26, 1975, a meeting was held at the Transportation Laboratory to discuss encasement requirements for polyethylene thermoplastic gas pipelines within State highway right-of-way. The meeting was attended by the following persons:

PUBLIC UTILITIES COMMISSION

Irving Hogan

SOUTHERN CALIFORNIA GAS CO

Jerry Lucas
Jim Sharp

PACIFIC GAS AND ELECTRIC CO.

Bill Ross
Tom Temen
Tom Benson

DEPARTMENT OF TRANSPORTATION

Dave Currier
George Hughes
George Ebenhack
Roy Chalmers
Al Banke
Bill Hoversten
Walt Kubasek
Bob Stoker
John Dusel
Roland Swirsky

Travis Smith] Longitudinal
Bill Green] Encroachment
Glenn Whitt] Committee

The following agenda was distributed at the meeting:

I. Purpose

II. Items for Discussion

A. Costs

B. Methods and Problems of Installation

1. New

2. Modifications

3. Repairs

C. Potential Hazards, Precautions, Liabilities

D. Specifications

1. Quality Control

E. Current and Future Research

The following paragraphs summarize discussions about items on the agenda, as well as other subjects related to the encasement of plastic pipe.

I. General Information about Polyethylene Plastic Pipe

The thermoplastic pipe used by P. G. & E., the Southern California Gas Company and most other gas utility companies is a medium density polyethylene designated as PE 2306 which conforms to ASTM Designation: D2513. The long-term ductility of this material is due to its molecular structure and the manner in which the molecules are linked as opposed to the addition of various plasticizers. Polyvinylchloride is prone to embrittlement due to these additives and therefore is not used by the principal utility companies.

Operating pressures are limited to 60 psi while 500 to 600 psi is required to burst the pipe in short-term rupture tests.

Four inches is the maximum diameter currently used. Pipes up to 3" in diameter come in coiled 1500 foot lengths. Four inch diameter pipe comes in straight 38 foot lengths.

Minimum soil cover generally required by the P.U.C. and the California D.O.T. is thirty inches but certain districts require greater cover, up to 42 inches being the minimum.

Impact and earth loadings are not critical for pipes up to 6 inches in diameter according to Tom Benson of P. G. & E. The thickness of the pipe wall is governed by internal pressure requirements and population density in the area of installation.

II. Specifications and Regulations

Walt Kubasek and Glenn Whitt noted that there is much inconsistency in installation procedures allowed from one district to another.

The absence of specific encasement requirements for plastic pipe in both the May 1974 Policy on Encroachments in Highway Rights-of-Way booklet and the Public Utilities Commission General Order No. 112-C leaves room for confusion and different interpretations of these regulations and codes. A study of the attached excerpts from these documents will reveal the indefinite nature of the current regulations. See Sections 3-3.1 and 3-5.1 of our encroachment policy and Sections 192.321 and 192.323 of P.U.C. G.O. No. 112-C.

III. Costs

Bill Ross stated that the greatest expense incurred by the Gas companies with metal pipe gas lines results from maintenance and monitoring of cathodic protection systems which are not necessary for plastic pipe. The additional labor, equipment and material required for encased installations increases initial costs as well. The gas company representatives estimated that they saved 20 to 50 percent in cost when encasement is not required. Their present practice is to use plastic pipe up to the highway right-of-way and cathodically protected, coated steel pipe within the right-of-way. This practice is cheaper than encasement of the plastic pipe.

Mr. Hogan of the California P.U.C. pointed out that all these costs are ultimately borne by the users of the utility and not by the utility companies. He expressed the opinion that the added cost was small considering the added safety he feels is achieved with encasement. This point was indirectly further substantiated by Bill Ross of P. G. & E. who stated that the amount of gas pipe within the highway right-of-way is but a minuscule amount of the total system.

IV. Concern for the Public's Safety

Glenn Whitt stated early in the meeting that the State's prime concern in making a decision to qualify plastic gas lines without encasement should be for the safety of the traveling public as well as for our own maintenance and landscaping crews.

It was also pointed out that any additional excavations within the road right-of-way might cause motorist inconvenience, increased accidents due to traffic congestion, and greater probability of injury to workers due to traffic exposure.

The utility companies are bound by some general P.U.C. restrictions (Section 192.123) regarding the use of plastic pipe in areas of high population density near inhabited buildings, however there is apparently little concern on their part for developing specific rules or design criteria for use of plastic pipe in high density traffic areas.

Both gas companies felt that it would be perfectly safe to discontinue encasement requirements of both longitudinal and transverse underground gas line crossings of plastic pipe, and felt that continuation of enforcement of the current policy would be unnecessary. It was also mentioned that repairs of plastic pipe could be done more easily and quickly than could repairs on steel gas lines, in the event of damage although the companies do admit that plastic pipe is more susceptible to damage than steel lines.

V. Methods and Problems of Plastic Pipeline Installation

A. Boring

Boring is the primary method used to install polyethylene pipe. Bentonite, a clay-slurry, is used as a lubricating and backfill medium for boring and pipe placement. When the pipe is pulled through a bored hole, the lead-end is examined for damage. Scratches or gouges over 10% of the pipe's wall thickness are considered unacceptable by P. G. & E. despite tests which indicate no loss of structural integrity with scratches or gouges 20% of the wall thickness in depth. Under these conditions the entire length of pipe is either withdrawn and the hole rebored or the pipe is cut and spliced to remove the severely damaged sections.

B. Joining Pipe Sections

Both companies agreed that the quality of a joint is highly dependant upon well-trained personnel using specialized equipment and techniques and they therefore conduct extensive training in this area.

For pipe diameters up through and including 4 inch, the pipe is joined by heat fusion welded sleeve couplers except that P. G. & E. uses a heat-fusion butt-weld for their four inch diameter lines.

The qualities of the bead which forms around the periphery of the joint in the process of fusion is taken as a reliable and positive indicator of the soundness of the joint.

C. Pipeline Identification

Presently, each pipeline is delineated by sign-posts, markers or monuments; the method of marking gas line locations is to be standardized nationwide. A continuous metallic wire or tape is affixed to plastic pipe to facilitate its location with conventional pipe locators. An exception to this procedure occurs in joint trench installations where steel pipes or electric lines for other utilities are laid adjacent to the plastic line.

VI. Damage Susceptability and Safety Hazards

A. History of Use

Southern California Gas Company has been using plastic pipe since 1969 while P. G. & E Company started in 1965. Failures to date have primarily resulted from third-party "dig-ins" or pipe damage due to excavation which are currently almost impossible to prevent. The number of failures has not increased substantially with the use of plastic pipe.

B. Damage Due to Rodents

Bill Ross of P. G. & E. mentioned that the potential for plastic pipe damage due to rodents chewing on the pipe is very small. Only one instance was reported of a gopher gnawing through a pipe. The pipe has no nutrient value and is not especially attractive to burrowing animals. The chance of a pipe being severed by rodents seems to be limited to those remote instances when a pipe just happens to be in the way of the burrowing animal.

C. Gas Explosion Hazards

When a gas line, plastic or steel, is severed the danger of ignition or explosion is very high. Plastic pipe develops a static electrical charge from the blowing gas whereas steel pipe will produce sparks when struck with equipment.

D. Damage Hazards Due to Excavation or "Dig-In"

The two gas companies admitted that plastic pipe is much more susceptible to damage by excavation than steel pipe, however when a plastic line is "hit" the damage is readily visible and limited to the immediate contact area. Damage to a steel line is not always apparent. The effects of impact are transmitted along a steel line due to its rigidity. An adjacent joint or other joint along the line could conceivably be weakened or damaged, and the leak would not necessarily be detected at the time or point of impact. In any event steel pipe is not immune to damage caused by external operations.

Because of the dig-in problem, which is not unique to the gas industry, efforts have been made to institute a "one-call" center. The phone number for this center will be displayed on the gas line markers along with instructions to call the center before commencing excavation, grading or digging operations. Upon receipt of a call, the center would then notify the appropriate utility company. Bill Ross of P. G. & E. feels this would lead to a 50 percent reduction of dig-ins.

E. Settlement Hazards

Concern about possible failure or collapse of unencased plastic pipe installed in fill areas was shown where differential or excessive settlements might occur. P. G. & E. Company pointed out that when plastic pipe was initially used, they had encountered many leaks where small flexible gas lines had been attached to rigid mains. The unencased flexible plastic pipe tended to fracture at the connection where movement of the plastic pipe was not permitted. The problem was remedied by installing a special fitting at the plastic pipe - steel pipe junction, allowing for flexibility and movement of the plastic pipe near the junction.

F. Chemical Degradation of Pipe

The gas companies claim that the polyethylene pipe used is free from attack due to acids or alkalis normally present in the soil and also due to the constituents found in natural gas with one exception. Occasionally there are aromatics in the gas which condense out in the form of droplets at the pumping plant discharge. These aromatics in liquid form will soften and weaken the pipe. The attack is limited to a percent of the thickness of the pipe wall. When the gas dries out, the pipe regains its initial properties. Any aromatic condensate is not continuous and the condensate is evaporated by the remainder of the gas as it flows down the pipe. Therefore any attack on the pipe from this source is limited to a relatively close distance from the pumping plant and would not generally be of concern for any length of pipe within the highway right-of-way.

VII. Current and Future Research

On-going research in the areas of stress-cracking, wall-buckling, and fatigue of plastic pipe is primarily concerned with large diameter pipe (8" and up).

Jerry Lucas stated that new plastics, if developed, will be investigated with the idea of using plastic pipe under higher operating pressures.

There are no results available for long-term testing of plastic pipe (over 15 years) according to the gas companies, and only educated guesses can be made as to the useful service life of plastic pipe. Test results to date of plastic pipe show no evidence of deterioration.

There seems to be little concern with the durability of small diameter plastic pipe as used by the gas companies based on research performed to date by DuPont and the Batelle Memorial Institute.

VIII. Conclusions

It was generally agreed that the meeting was timely and much information and knowledge regarding the encasement of plastic pipes was disseminated and shared.

Although many opinions were probably formed as a result of the meeting, no final decisions regarding encasement policies were made.

John P. Dusel, Jr.
Associate Materials and Research
Engineer - Structural Materials Branch

JPD:bjs

cc: EF Nordlin
JP Dusel
JR Stoker

C. UTILITY COMPANY RESPONSES TO SAFETY QUESTIONNAIRE

SOUTHERN CALIFORNIA gas COMPANY

8101 SOUTH ROSEMEAD BOULEVARD • PICO RIVERA, CALIFORNIA

ENGINEERING DEPARTMENT

Mailing Address BOX 3249 TERMINAL ANNEX, LOS ANGELES, CALIFORNIA 90051

August 29, 1975

Department of Transportation
Division of Construction and Research
Office of Transportation Laboratory
5900 Folsom Boulevard
Sacramento, California 95819

Attention: Mr. George A. Hill

The following information is being submitted in response to your letter requesting information on the safety aspects of polyethylene plastic pipe.

1. Is there a possibility of either ignition and/or explosion of natural gas resulting from a "dig-in" of encased or unencased plastic pipe?

   The possibility of ignited escaping gas from "dig-in" damage does exist with plastic pipe as it does with other piping materials. This hazard from "dig-in" damage to all materials has long been recognized as a major pipeline safety concern.

2. Is the potential danger of ignition or explosion greater when using either:

   (a) Unencased plastic vs. encased plastic lines -

   A steel encased plastic pipe would have more resistance to "dig-in" damage because of higher material strength. This higher strength is not sufficient to preclude the possibility of line break, since the mechanical force exerted by the digging equipment can exceed the material strength.

   Once a break does occur, the likelihood of ignition at the point of impact appears to be the same regardless of the encasement, although presence of the steel casing may cause sparking while removing the damaging tool.

GH 9/15/75

The likelihood of ignition remote from the point of impact, however, is greater when casing is used for two reasons. First, the casing leading from the hit point can serve as an underground path for gas to travel which can contribute to gas escape undetected at another location. Second, the casing complicates the gas control procedure which leads to a longer duration of gas escape, thereby increasing hazard exposure.

(b) Unencased plastic vs. unencased steel -

The impact resistance of steel pipe is greater than that of plastic, thus reducing the frequency of direct gas escape from "dig-in" damage. Once the line is broken, the likelihood of gas ignition at the break point is approximately the same. As with cased plastic, the likelihood of remote leakage is higher with steel pipe. This is due to the steel pipe's ability to transmit the force of excavation equipment impact to a remote location, at times causing undetected underground leakage many feet from the "dig-in" site.

3. If ignition or explosions are possible, how many instances due to damage of plastic or steel pipe during typical installations or "dig-ins" have you or your company experienced or of which you have knowledge?

4. In these cases of ignition or explosion, what was the extent of any injury or damage to people, equipment, automobiles, or structures?

The incidents that follow have predominately occurred in private property not public property, with not a single incident occurring in a state highway. The successful prevention of "dig-in" incidents in state highways demonstrates the effectiveness of stringent permitting and inspection procedures in preventing "dig-in" damage, regardless of the material involved.

The following list summarizes Southern California Gas Company's experience of "dig-in" and installation incidents resulting in ignition, from 1970 to date. All of these incidents have been formally reported to the California Public Utilities Commission.

Mr. George A. Hill
Department of Transportation

August 29, 1975

DATE	LOCATION	FACILITY	CONSEQUENCES
7/4/70	Warner Av E/o Edwards Av Huntington Beach	Plastic Service	Trencher Damaged
11/23/70	1205 W. 13 St., L. A.	Steel Service	No injury or property damage
1/9/71	364 Mount Pinos Way Frazier Park	Steel Service	No injury or property damage
4/26/71	7700 Le Berthan St. Los Angeles	Steel Service	No injury or property damage
5/13/71	1483 Camino Rio Verde Santa Barbara	Plastic Service	Trencher Damaged
12/15/71	3928 W. 104 St. Inglewood	Plastic Service	Building Damaged
5/12/72	268 Bel Air Road Los Angeles	Steel Service	One injury
5/23/72	8810 Alondra Blvd. Paramount	Steel Service	Building Damaged
10/6/72	3430 Union Pacific Av	Steel Service	6 injuries; 1 fatality; Bldg. destroyed
12/19/72	Merced Av @ Big Dalton Av Baldwin Park	Steel Main	1 injury
2/20/73	24712 Chestnut Newhall	Steel Service	1 injury; Bldg. damaged
6/7/73	3006 Quinnell Dr. West Covina	Steel Service	Bldg. damaged
10/3/73	Enos Lane & Munzer Rd. Kern County	Plastic Main (Installation)	3 injuries

Mr. George A. Hill
Department of Transportation

August 29, 1975

DATE	LOCATION	FACILITY	CONSEQUENCES
10/20/73	749 Via Los Santos San Dimas	Plastic Main	Garage Damaged
1/7/74	453 Woodley Road Crestline	Steel Main	House Destroyed
8/12/74	Riverton Av & Ostego St. North Hollywood	Plastic Main	1 injury
9/4/74	101-05 Santa Ana Av. Oxnard	Steel Service	5 injuries; 1 fatality; Bldg. destroyed
6/30/75	Monte Vista E/o Demare Visalia	Plastic Main	1 injury

The use of plastic pipe for gas piping on a national scale has exceeded all projections for the last five years. Coupled with the increased usage is the wide acceptance by local, state and national agencies. In summary, we feel that plastic has demonstrated the ability to equal or exceed steel in overall performance as a gas piping material.

Sincerely,

J. L. Lucas

J. L. Lucas

JLL:bf

File: Tokay, Pipeline Crossings

PACIFIC GAS AND ELECTRIC COMPANY

PG and E 77 BEALE STREET • SAN FRANCISCO, CALIFORNIA 94106 • (415) 781-4211 • TWX 910-372-6587

July 25, 1975

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Department of Transportation
Division of Construction and Research
Office of Transportation Laboratory
5900 Folsom Boulevard
Sacramento, California 95819

Attention: Mr. George A. Hill

Gentlemen:

In answer to your letter of June 16, 1975, we submit the following information.

1. Is there a possibility of either ignition and/or explosion of natural gas resulting from a "dig-in" of encased or unencased plastic pipe?

   There is always the possibility of either ignition or explosion when natural gas is escaping. The frequency of ignition or explosion is low as compared to the total number of dig-ins. Our experience indicates that the potential for accidental ignition is about the same for either plastic or steel systems, however, encasement can introduce other problems. Please refer to our comments under "2".

2. Is the potential danger of ignition or explosion greater when using either:

   (a) Unencased plastic versus encased plastic lines.
   (b) Unencased plastic versus unencased steel lines.

   Since plastic pipe has lower mechanical strength, it is more easily damaged as compared to steel pipe, however, it is much easier and faster to repair because of its easier handling characteristics and this is very important when considering rapid control of emergencies and public safety. The casing of plastic will limit access, thereby making repairs extremely difficult and in addition, would tend to channel leakage to remote or unsuspected areas.

   As stated previously, it is our experience that accidental ignitions do not seem to be particularly influenced by carrier materials but occur on a random basis. Ignitions occur from third party action, carelessness in working around a flammable substance and in other cases the occurrence cannot be attributed to any identifiable cause.

8/1/75

In addition, most leakage in our system is caused by corrosion of steel carrier pipe, much of which results from equipment damage which, while not breaking the pipe does damage wrapping to the extent that leakage later occurs on the system. More instances of ignition or explosion have occurred in our system because of this type of leak than any other cause. Cathodic protection can be effective in controlling leakage but requires constant monitoring.

3. If ignition or explosions are possible, how many incidents due to damage of plastic or steel pipe during typical installations or "dig-ins" have you or your company experienced or of which you have knowledge?

The following data is given:

<u>1975 - FIRST SIX MONTHS</u>

1 plastic service ignited by torch, no injuries.

<u>1974</u>

5 plastic services struck by excavator.
1 steel service struck by excavator.
1 steel main ignited by arc welding, one injury.
7 total.

<u>1973</u>

3 plastic services struck by excavator.
1 plastic main melted by welding operations.
4 total.

<u>1972</u>

1 plastic service ignited by torch.
1 steel main hit by dozer.
1 plastic main hit by trencher, one injury.
1 high pressure steel gas field gathering line hit by dozer, dozer destroyed.
4 total.

Statistics do not relate the entire picture. For example, the dig-in rate and subsequent incidents of ignitions are higher in the plastic category because we are now using almost 100 percent plastic in new areas, such as residential and condominium developments where construction of one type or another is prevalent and the exposure to dig-ins is greater. In contrast, ignition or explosion rates are overall much higher in the steel system, mostly due to steel corrosion leaks.

Our system now contains approximately 4,500 miles of plastic mains and services and is being installed at the annual rate of about 1,400 miles per year. Over 80 percent of our pipe now being installed in our system is plastic.

4. In these cases of ignition or explosion, what was the extent of any injury or damage to people, equipment, automobiles, or structures?

Damages in most of the above incidents was minimal. In the case of the incidents where injuries were mentioned the injuries were mostly minor burns, no fatalities. Damage to structures was also minimal.

Yours very truly,

W E Ross

W. E. ROSS
Supervising Gas Engineer
Gas Distribution Department

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